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APPLICATION FOR UNITED STATES LETTERS PATENT

INVENTOR

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TITLE

METHOD FOR PRODUCING OIL TEMPER WIRES

This application claims priority of Japanese Patent Application No. 2002-211,954 filed July 22, 2002; and, International Patent Application No. PCT/JP03/06546 filed May 26, 2003.

SPECIFICATION

METHOD FOR PRODUCING OIL TEMPER WIRES

TECHNICAL FIELD

The present invention relates to a method for producing an oil temper wire for use in a coil spring or a valve spring used in an internal combustion engine, a torsion spring used in a clutch mechanism for an automobile and the like.

BACKGROUND

There has been known a method for producing an oil temper wire for a coil spring, the method comprising: using a wire material having a nonmetallic inclusion controlled and carrying out an isothermal transformation heat treatment, applying a lubrication film after acid washing, carrying out scalping or shaving, then carrying out an isothermal transformation heat treatment, applying a lubrication film after acid washing, carrying out wire-drawing processing, and finally applying an oil temper treatment. In this case, the isothermal transformation heat treatment with a wire material is often omitted since workability of a wire material is enhanced.

The conventional method for producing an oil temper wire which carries out the isothermal transformation heat treatment after the scalping has been carried out includes: (a) Since the wire material is heated to a degree in excess of a transformation temperature, decarburization likely occurs; (b) since the isothermal transformation heat treatment requires a traveling treatment with a strand, a dominant cause of producing a damage caused by the traveling treatment and handling results; (c) in the isothermal transformation heat treatment, a removal of an oxidized scale film produced during the heat treatment and the lubrication film treatment after

acid washing in order to wire-drawing processing are necessary; and (d) an adhering state of the oxidized scale in the oil temper treatment after wire-drawing is uneven due to unevenness of the lubrication film after acid washing resulting in an evil of forming process of a coil spring (coiling).

DISCLOSURE OF THE INVENTION

In view of the aforementioned problem, it is an object of the invention to provide a method for producing an oil temper wire, which improve quality, achieve reduction in cost, and simplifying the steps after the scalping.

It is a further object of the invention to provide a method for producing an oil temper wire which is free from decarburization of a wire material and free from a damage or unevenness of scale on a surface layer after an oil temper treatment has been carried out, to facilitate forming of a coil spring.

For solving the problems noted above, a method for producing an oil temper wire according to the present invention comprises: applying an isothermal transformation heat treatment to a wire material having a nonmetallic inclusion controlled; applying a lubrication film after acid washing; carrying out scalping or shaving after which softening a work hardened lyer produced on a surface layer at the time of scalping by annealing and carrying out wire drawing, and then carrying out an oil temper treatment.

OPERATION OF THE INVENTION

The present inventor has found that in a method for producing an oil temper wire using a coil spring, to carry out annealing after scalping or shaving of a wire material having a nonmetallic inclusion controlled is effective for a thereafter wire drawing process. That is, the method for producing an oil temper wire for use in a coil spring resides in that a work

hardened layer produced on a surface layer of a wire material during scalping of a wire material is softened by annealing to thereby remove an evil, and after wire drawing, an oil temper treatment is carried out.

Considering a wire drawing workability and a solid solution state of cementite caused by austenite heating at the time of an oil temper treatment after wire drawing process, an annealing temperature of a wire material is set to a temperature region from 500 to 650℃. For the atmosphere at the time of annealing, nitrogen or a mixture of nitrogen and oxygen is used, and particularly, the quantity of oxygen is preferably controlled. A control is made such that an oxidized scale film produced by annealing of a wire material is extremely thin and even. Thus, it is possible to omit the coventional lubrication film treatment after acid washing for wire drawing process.

A film of an oxidized scale caused by annealing prior to a wire drawing process of a wire material may be subjected to descaling by means of a shot blast or the like. By making an oxidized scale film due to annealing of the material wire even, the thickness of the oxidizedscale after succeeding oil temper process becomes even, and lubricating property at the time of forming process (coiling) of a coil spring can be maintained.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a photograph showing a surface crack of one wire material according to the method for producing an oil temper wire according to the present invention; FIG. 2 is a photograph showing a solid solution state of one more material according to the method for producing an oil temper wire; FIG. 3 is a schematic view representative of an evaluation standard in a coil winding state of a wire material according to the method for

producing an oil temper wire; and FIG. 4 is a photograph showing a decarburization state of a comparative wire material.

BEST MODE FOR CARRYING OUT THE INVENTION

The method for producing an oil temper wire according to the present invention is characterized by removing evils scalping or shaving a wire material, softening a work hardened layer produced by annealing to thereby remove an evil, and after wire drawing is carried out, carrying out an oil temper treatment.

[Embodiment 1]

There were prepared wire materials A to G and H, as oil temper wires, in which an alloy steel inclusion is controlled, comprising carbon 0.57% (hereinafter, % means weight % unless otherwise particularly described clearly), silicone 1.45%, manganese 0.69%, phosphor 0.014%, sulfur 0.004%, chromium 0.67% and iron (the reminder) and a comparative material H, these materials were subjected to an isothermal transformation treatment, applying a lubrication film after acid washing, and scalping or shaving of the surface. The scalping amount of a wire material is 0.3 mm in diameter (thickness 0.15 mm). Then, annealing of a wire material by batch was carried out in an atomosphere of mixed nitrogen and oxigen. An annealing temperature of a wire material was varied from 480 to 700℃ to confirm workability of drawing of the wire materials A to G and the comparative material H at respective annealing temperatures. The state of the oxidized scale film after annealing of the wire material was extremely thin and even. Further, the decarburization of the wire materials A to G in annealing was not recognized, but the decarburization in the comparative material H was not recognized, as shown in FIG. 4.

Next, the oil temper treatment was carried out with respect to a wire material, which is good in drawing wire process. The solid solution state (refer to FIG. 2) of cementite at the time of oil temper treatment was confirmed. In the oil temper treatment, since heating time is short, when the cementite is formed into sphere, the solid solution of cementite is insufficient by heating and adequate strength is not obtained.

A relationship between the annealing temperature and the drawing wire workability after the wire materials A to G in which an inclusion was controlled and the comparative material H were subjected to the isothermal transformation treatment, application of a lubrication film after acid washing, and scalping or shaving of the surface is as follows:

Wire material A: At an annealing temperature of 450℃, a breakage occurred during the drawing wire process, which was not practical.

Wire material B: At an annealing temperature of 480℃, the drawing wire process in excess of 80% of reduction of area was accomplished, but crack-like crevices at right angle to a fine wire axis occurred on the surface of the wire material, as shown in FIG. 1.

Wire materials C to F: At an annealing temperature of 500 to 650℃, a crack-like crevice at right angle to a fine wire axis was not recognized, and the cementite was not found to be formed into sphere. By austenite heating after drawing wire process, the cementite was sufficiently subjected to solid solution to obtain adequate strength. No unevenness was recognized on the external appearance of the oxidized scale film after the oil temper treatment.

Wire material G: In the annealing at a temperature of 700℃, formation of cementite into sphere progresses, and the solid solution of spherical-

cemêntite is insufficient due to the austenite heating after the drawing wire process, failing to obtain the adequate strength.

Comparative material H: Unevenness was recognized on the external appearance of the oxidized scale film after the oil temper treatment.

Evaluation circumstances of the aforementioned wire materials A to G and comparative material H are summarized in Table 1. The adequate annealing temperature is 500 to 650℃ of the wire materials C to F.

TABLE 1 Evaluation Results

Wire Mat'ls	heat treatment system	temp. ℃	ato'phere	decarb'tion	thick'ns scale	drawing workability
A	annealing	450	nitrogen	O	0 to 1	X
B	annealing	480	nitrogen	O	0 to 2	△
C	annealing	500	nitrogen	O	1 to 3	O
D	annealing	550	nitrogen	O	1 to 3	O
E	annealing	600	nitrogen	O	1 to 3	O
F	annealing	650	nitrogen	O	2 to 5	O
G	annealing	700	nitrogen	O	3 to 8	O
H	annealing	500	redution	△	2 to 15	O

Wire Mat'ls	oil temper solid solusion state	scale uneveness	eddy current crack detection crack number	synthetic evaluation
A	-	-	-	X
B	-	-	-	X
C	O	O	0	O

D	O	O	0	O
E	O	O	0	O
F	O	O	0	O
G	△	-	-	X
H	O	X	7	X

After the oil temper treatment, the inspection of cracks by eddy current crack detection was conducted over the full length on the off line. In the wire materials C to F subjected to the batch type annealing treatment, there is no number of cracks per coil (diameter: 6 mm, and length: 1500 m), whereas in the comparative material (which was subjected to the isothermal transformation heat treatment after scalping), seven cracks per coil were found.

In FIG. 3, A shows no scale-enevenness is present over the full length of the coil. B shows several times of scale-unevenness are found in a few places within the coil. C shows scores of rolls of scale-unevenness are found in one place within the coil. D shows scale-unevenness in which B-C are combined.

TABLE 2 Evaluation items

Evaluation items	evaluation standard
Decarburization	partial decarburization is not present
Workability	(a) degressive rate is not less than 80%
	(b) defect such as scratch is not present on the surface after peocessing
solid solution state	cementite is solid solution dispersed evenly
scale unevenness	A and B in scale-unevenness judgment standard are accepted

[Embodiment 2]

A wire material, in which an alloy steel inclusion is controlled comprising carbon 0.65%, silicone 1.53%, manganese 0.69%, phosphor 0.007%, sulfur 0.008%, chromium 0.68%, and iron (the reminder), which are different in component from Embodiment 1 was subjected to an isothermal transformation treatment, applying a lubrication film after acid washing, and scalping of a surface in diameter of 0.3 mm (thickness is 0.15 mm). The scalping amount of a wire material is 0.3 mm in diameter (thickness 0.15 mm).

Then, annealing of a wire material by batch was carried out. The annealing temperature was 500℃. The annealing treatment was carried out with respect to the wire material, after which the wire was drawed to an adequate diameter, and then the oil temper treatment was carried out. At this time, abnormality caused by the wire drawing process, the short in strength in the oil temper treatment, and abnormality such as unevenness of scale were not occurred.

[Embodiment 3]

As an oil temper wire used as a high fatigue strength material, a wire material, in which an alloy steel inclusion is controlled comprising carbon 0.64%, silicone 1.43%, manganese 0.71%, phosphor 0.006%, sulfur 0.005%, chromium 1.48%, molybdenum 0.47%, vanadium 0.19% and iron (the reminder) was applied with a lubrication film after acid washing, and scalping of a surface in diameter of 0.3 mm (thickness is 0.15 mm) was carried out. Then, the annealing treatment was carried out at 600℃ with respect to the wire material by the batch. Then, the wire drawing process was carried out with respect to the wire material, after which the oil temper

treatment was carried out.

Also in the aforementioned high fatigue strength material, the abnormality caused by the drawing wire process, the short in strength in the oil temper treatment, and the abnormality such as unevenness of scale were not occurred.

INDUSTRIAL APPLICABILITY

As described above, the method for producing an oil temper wire used for a valve spring of the internal combustion engine, a coil spring of a clutch mechanism and the like according to the present invention is useful in the point that no scratch and unevenness of scale occur on the surface layer after the drawing wire process and oil temper treatment, and forming of a coil spring is facilitated.